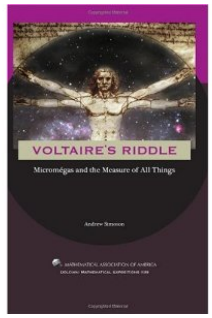
Voltaire's riddle. Micromégas and the measure of all things *Andrew J. Simoson*, Volume 39 of Dolciani Mathematical Expositions, Mathematcal Association of America, 2010 (xvii+377 p.), hard cover, ISBN 978-0-88385-345-0.

A.J. Simoson



cover

Voltaire

The Dolciani series of MAA is a quality label since books are selected 'for their lucid expository style and stimulating content' both for undergraduates and for more advanced mathematicians. Simoson presents here his second volume in the series. The first one was *Hesiod's Anvil* (2007), following a similar style as this one.

Micromégas and the 'dwarf' from Saturn releasing the ship of the human philosophers. Engraving by Charles Monnet

He received the MAA Chauvenet Prize in 2007 awarded to 'an author of an outstanding expository article on a mathematical topic' for his paper on *The gravity of Hades*.

Voltaire was a thoroughbred product of the Age of Enlightenment. Poet, playwright, philosopher, but it may be less known that he also relates to mathematics. He was responsible for the French translation of Newton's *Principia*[1], and he invented the story about Newton and his apple. However after persueing mathematics for several years, he was rated as only mediocre and he decided to go full-heartedly as a writer.

So what mathematics do we find here and what is Voltaire's riddle? Let me start with the *Micromégas*. That is a story by Voltaire which is considered to be one of the first Science Fiction stories ever written. Micromégas is a huge giant from a planet of the star Sirius, who travels to Saturn where he meets a 'dwarf' that is still a giant for human standards. They both arrive on earth where they meet the French expedition returning from the arctic where they measured the length of three angular degrees on the earth's surface. A similar expedition did measurements near the equator to settle the question whether the earth what flattened at the poles or at the equator, which was a big issue in Voltaire's days. Voltaire uses this to give a satirical account of human society. Anyway, the story ends abruptly when the giant gives a book to the humans containing the answers to everything, but it turned out that the book was empty. What is the meaning of this? That is Voltaire's riddle.

An annotated translation of the *Micromégas* forms the first chapter of this book. Some possible answers to the riddle are given in the last chapter. And then there are ten chapters in between dealing mainly with mathematical topics that are brought into relation with something related to Voltaire. The practical organization is that every chapter is preceded by a 'vignette', which is a short interludium telling something about Voltaire and his time, evoking a motive for the mathematics to follow.


LA FIGURE
DE
LA TERRE,
DÉTERMINÉE
PAR LES OBSERVATIONS
FAITES PAR ORDRE DU ROY
AU CERCLE POLAIRE.
Par M. de Maupertuis.
A PARIS,
DE L'IMPRIMERIE ROYALE.
M. DCCXXXVIII.

Report Maupertuis

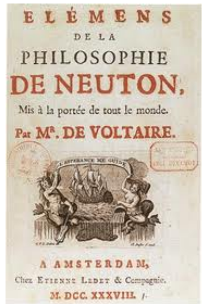
Maupertuis

Let me quickly give some vague ideas. Vignette 2 tells about giants that appear in the literature, while

[1]Voltaire was a lover of Émilie du Châtelet, and they had common teachers. Theachers like Maupertuis and Clairaut, that Voltaire hired since he was rich after finding a winning strategy with the lottery. However she actually did the translation.

chapter 2 is about measuring from the very large to the very small and self-similarity opening the road to cosmology and fractals. The next vignette tells about Voltaire's rebellious nature and how he ended up in the Bastille. A parallel is seen in A. Square, the inhabitant of E.A. Abbott's Flatland who is imprisoned too for his controversial ideas. But this involves true mathematics because several models are considered for Flatland and two-dimensional gravitational models are worked out. Consider Flatland as an infinite rectangle of finite width with all mass concentrated on a line parallel to the baseline, what would be the path of a thrown ball?

Émilie du Châtelet



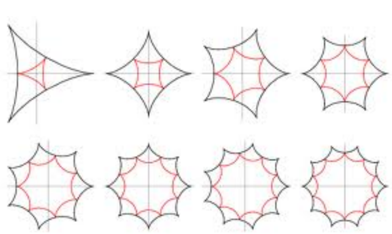
Voltaire's Elements

Then the story is told about Newton trying very hard to become a mathematician, which culminated but also ended with his *Elements of Newton's Philosophy* (*Eléments de la philosophie de Newton*, 1738). It helped much in the popularization of Newton's work in France. He got however some poor reviews from people in the French *Académie*, so that Voltaire gave up mathematics, although he continued to support Émilie du Châtelet in translating Newton's work. The corresponding chapter is about Newton who solved the equations of motion and two case studies are worked out: to find out the spring-time period on a planet (the number of days between the winter and the summer solstice), and the voyage of Micromégas, in fact the orbit of a comet in the solar system.

More loosely connected is the story of Voltaire becoming rich thanks to the state lottery. La Condaminne, one of Voltaire's teachers, and also a member of the expedition that measured the arclength near the equator, detected a flaw in the lottery system. The trick was to buy as many low-cost tickets as possible. As a result they won six months in a row before the flaw in the system was detected. As a consequence the syndicate that bought the tickets had become very rich indeed. The vignette also has a discussion of the mathematical background of the earth being flattened at the poles, as Newton predicted, or at the equator, as the French Academy tended to believe, following the arguments of Descartes and propagated by Cassini in Newton's days. The Academy proposed to send an expedition to the Caribbean and another one to Lapland to measure one degree of arclength along the earth's surface. If Newton was right then the that should be longer near the poles than near the equator. Among the team going North were Voltaire's teachers Maupertuis and Clairaut. La Condaminne was among the team sent to Ecuador. They finished the job within a year, but the Caribbean team needed eight years. The outcome was that Newton was right, but the discussion went on for some time. Fifty years later Delambre and Méchain measured a meridian from Dunkirk to Barcelona by a similar triangulation[2]. That resulted in the definition of the meter.

Voltaire on an old 10 franc note

A short history and a remark of Voltaire about astrologers is an incentive to devote a chapter to the mechanics explaining the precession of the earth's axis. The next vignette is about Voltaire's love-life and romances, but the link with the chapter attached, which is 'about a romantic family of curves' is a bit weak. Nevertheless the discussion about trochoids, hypocycloids, and how Dürer used them in his art is interesting enough. Again a link with mechanics is made via Johann Bernouilli's riddle: Which path should a point in a gravitational field follow to move from A to B in the shortest possible time?

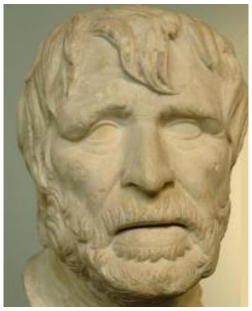


Hypocycloids

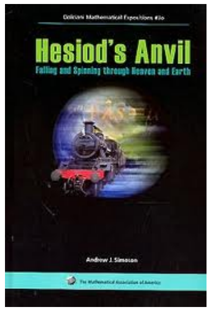
Also the next couple of chapters are related to some historical mechanical riddles. The first one is related to *Hesiod's anvil*, the author's previous book, where the question is raised what would happen if something falls into a hole through the center of the earth (Maupertuis was intrigued by this problem). Hesiot is a Greek poet (approx. 700 BC) who claimed that it would take about 9 days for an anvil to fall from the earth's surface to the underworld. Here Isaac Newton's claim that a freely falling pebble will describe an ellipse with respect to the stars. However much

[2]See the book review about "*Het meten van de wereld*" in this Newsletter issue 58 (2006).

more complicated situations are also considered, and then the curves of the previous chapter and more three-dimensional curves show up when the path has to be described, taking into account the movement of the earth within the solar system, and the place on earth where the hole is dug. The other one is about the ‘man in the moon’: what path one will follow when tracing a moving object, for example a rocket starting on earth and always pointing to the moon. The ‘man in the moon’ chapter about pursuit curves is a version of a paper that was published before and for which Simoson received the George Pólya Award in 2008, another prize given for ‘articles of expository excellence published in the *College Mathematics Journal*’.



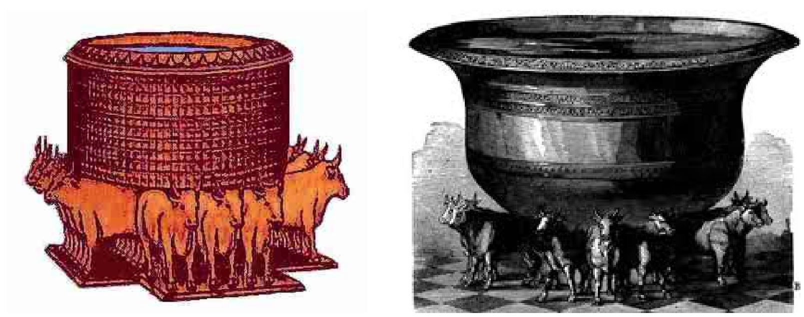
Hesiod



Hesiod’s anvil
by Simoson

The next chapter is about π, which is the number with the longest history. Here Simoson links it with Voltaire’s theological ideas and how π shows up in the Bible or more generally in the Jewish tradition. A central theme is a discussion of the form and the dimension of Solomon’s sea, a bronze basin, described in I Kings 7:23, where π is implicitly defined as 3. The penultimate chapter is a style break because it has no mathematics, but it is a story about Pantagruel’s (a giant invented by Rabelais) expedition to the moon. Rabelais had announced once Pantagruel’s adventures and him visiting the moon was one of them. However he never came around writing the story. So Simoson has picked up the tale. It raises the question of how one can measure something that is beyond the reach of technology at that particular moment. In this case the composition of the moon with the technology that Rabelais had available. It is impossible of course. The only thing one can do is dream and make a story out of ones imagination.

I will not reveal the possible answers for Voltaire’s riddle that are proposed by Simoson, but this review at least explains a bit of the riddle how Voltaire can be linked to mathematics. The mathematics involved are not always simpel. A good knowledge of (vector) calculus and linear algebra as well as differential equations is a minimal prerequisite.



Solomon’s sea

Each chapter end with a list of exercises, some of which get further comments in an appendix. But let me stress that not only the mathematics are well covered, also the historical facts that are presented are abundant and detailed. For example it is very well illustrated with a lot of pictures and graphs,the notes of the *Micromégas* story are very extensive, and there is also an appendix with a list of historical (and fictional) figures that feature in the book from king Solomon to Stephen Hawking and from Dante to Napoleon. Well, most of them since e.g. Hesiod is missing.

Simoson has created a kind of books that is different from any other type I have read. Not always the easiest mathematics, but the mathematics are well seasoned and always pushing the reader one step further than he might have been ready for, but there’s a lot of juicy and creamy little facts and small-talk from the history beyond the history books. There’s literature and fine arts, and often the unexpected like pyrolithic graphite, Jonathan Swift and George Orwell featuring on the same page. That keeps you reading on and on.

Adhemar Bultheel